Ch 15/16 Acids & Bases

Ch 15/16 Acids & Bases

Simple Properties of Acids + Bases

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Acids

Bases

Ch 15/16 Acids & Bases

Simple Properties of Acids + Bases

Acids

Low pH (Below 7)

Bases

high pH (above 7)

Ch 15/16 Acids & Bases

Simple Properties of Acids + Bases

Acids

Low pH (Below 7)

give off H^+ in soln

Bases

high pH (above 7)

give off OH^- in soln

Ch 15/16 Acids & Bases

Simple Properties of Acids + Bases

Acids

Low pH (Below 7)

give off H^+ in soln

electrolytes

Bases

high pH (above 7)

give off OH^- in soln

electrolytes

Ch 15/16 Acids & Bases

Simple Properties of Acids + Bases

Acids

Low pH (Below 7)

give off H^+ in soln

electrolytes

change color of indicators

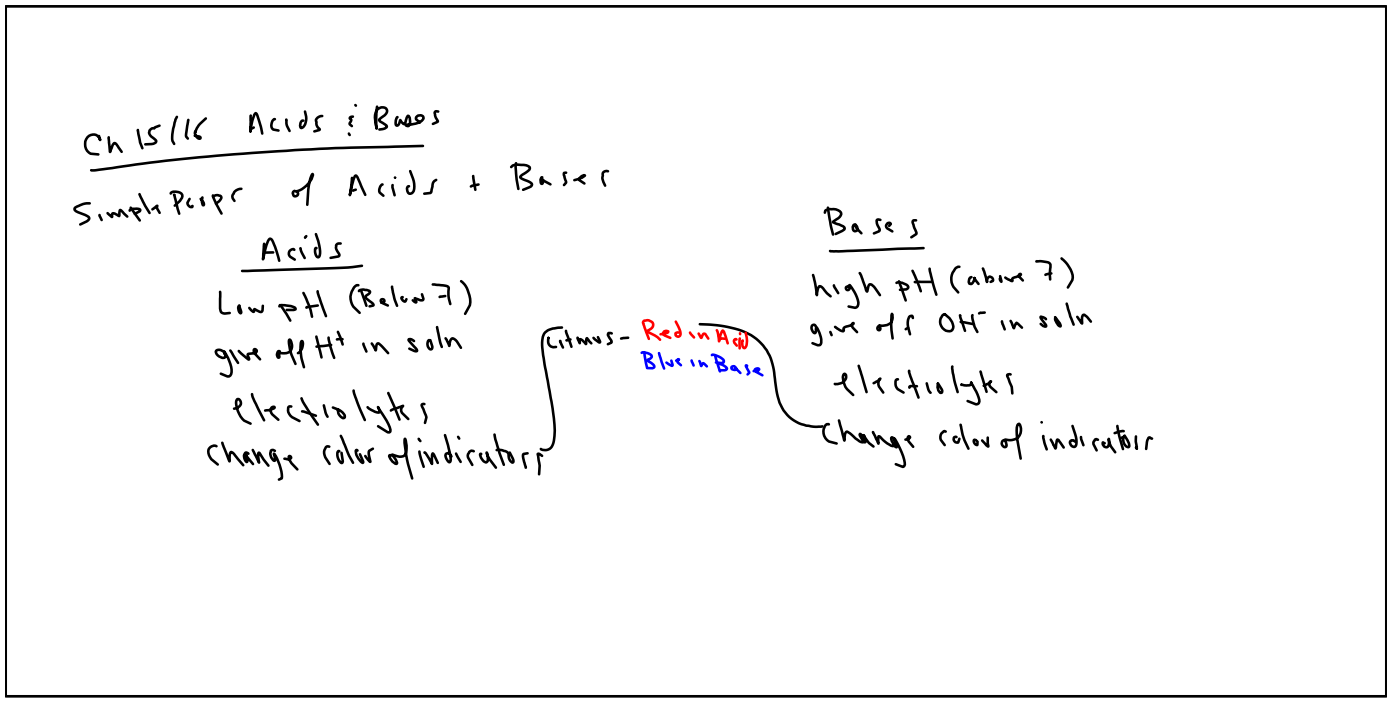
Bases

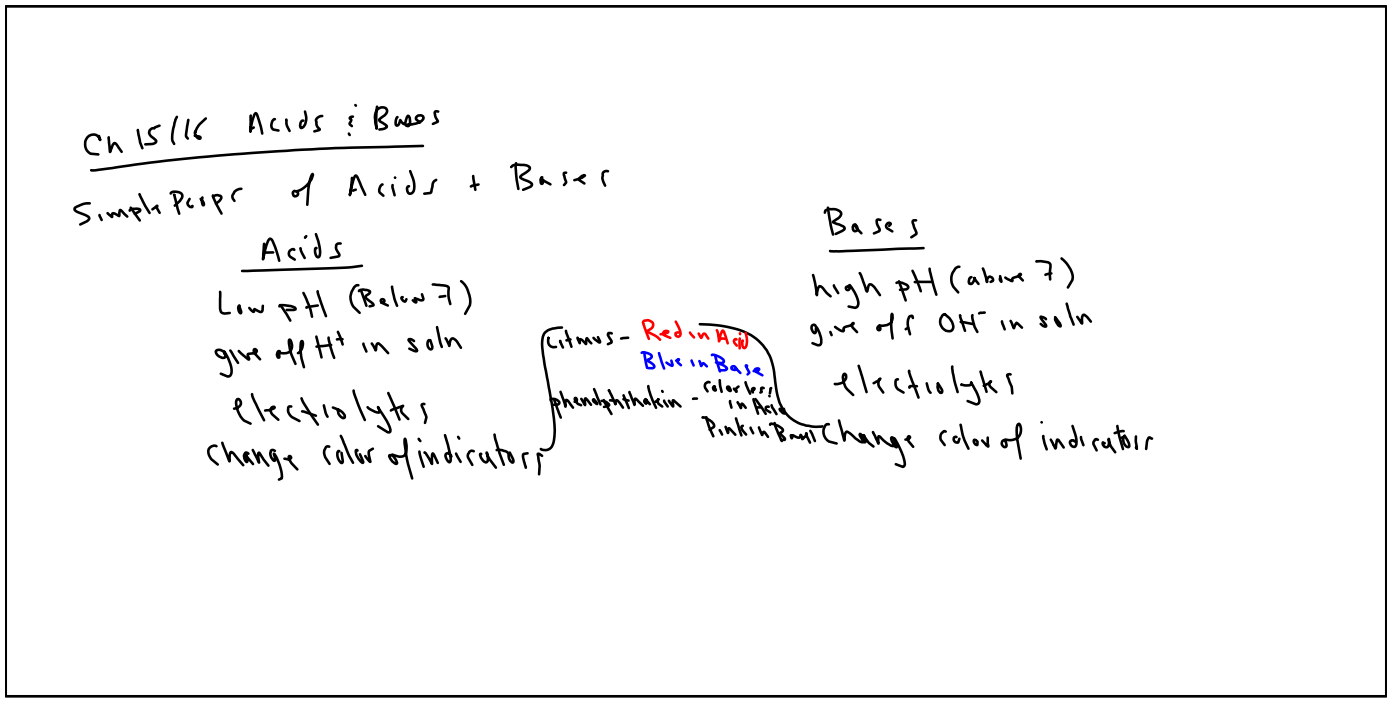
high pH (above 7)

give off OH^- in soln

electrolytes

change color of indicator


Ch 15/16 Acids & Bases
Simple Properties of Acids + Bases
Acids
Low pH (Below 7)
give off H+ in soln
electrolytes
change color of indicators
Litmus - Red in Acid
Blue in Base
Bases
high pH (above 7)
give off OH- in soln
electrolytes
change color of indicator


Ch 15/16 Acids & Bases
Simple Properties of Acids + Bases
Acids
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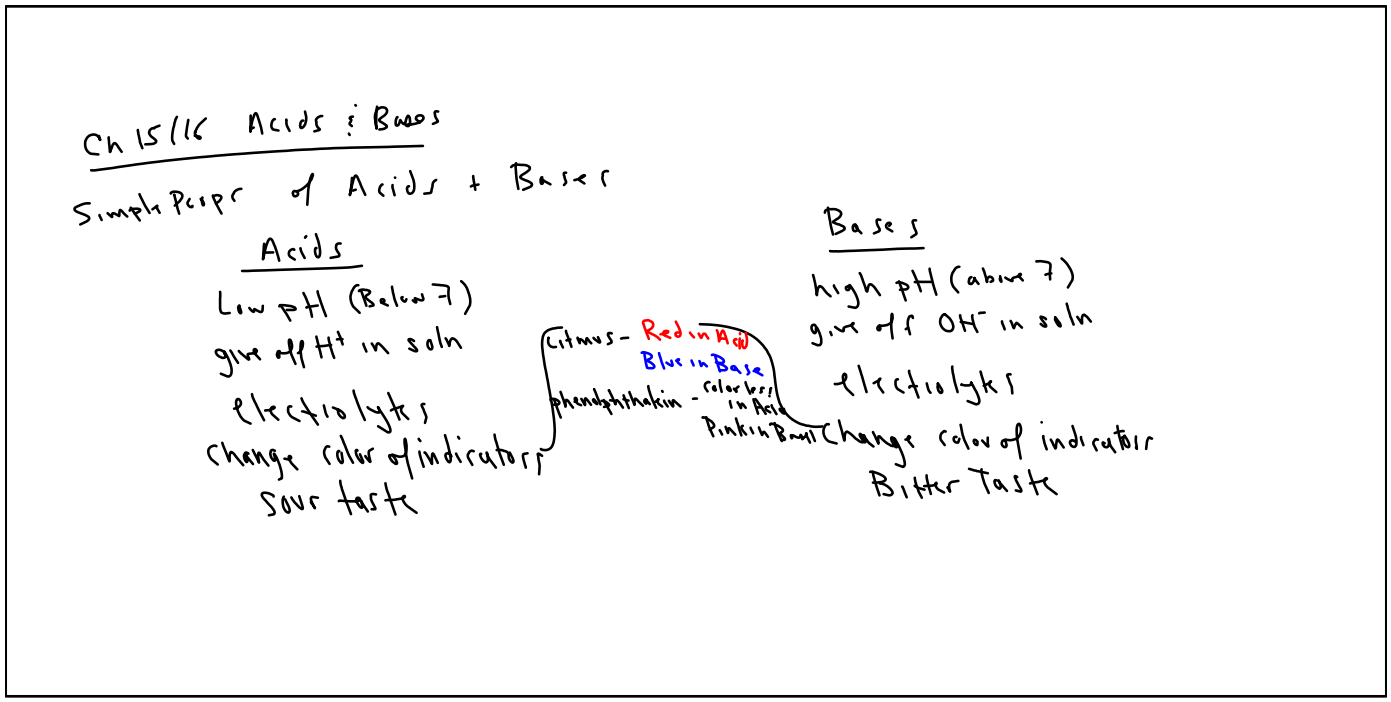
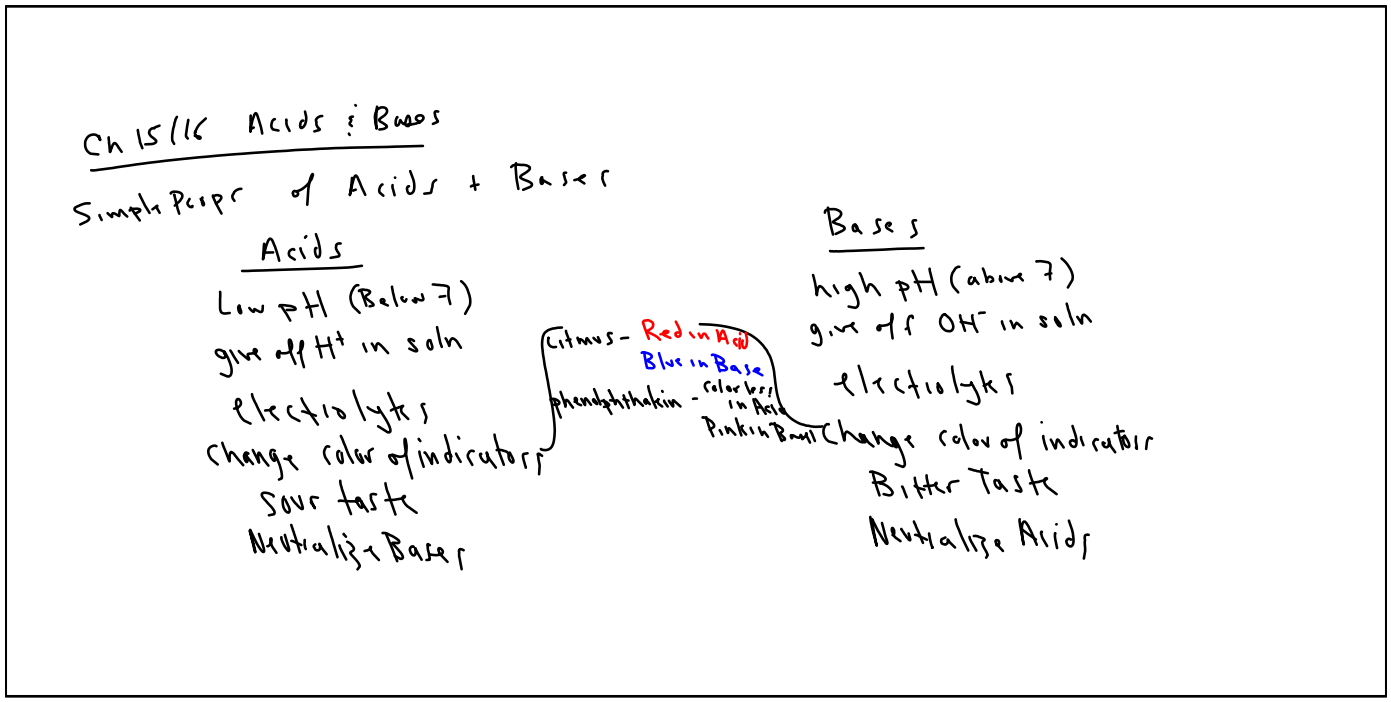
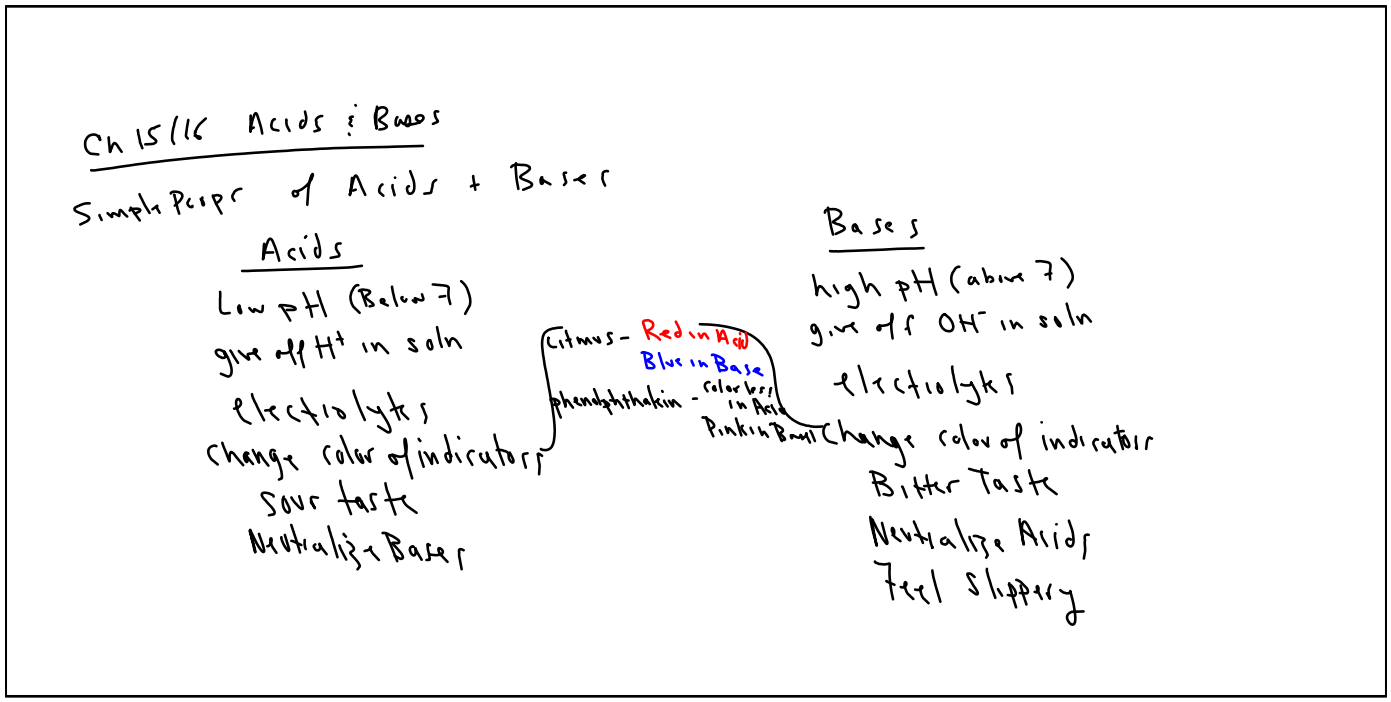
give off H+ in soln
electrolytes
change color of indicators
Litmus - Red in Acid
Blue in Base
phenolphthalein - colorless in Acid
Pink in Base
Bases
high pH (above 7)
give off OH- in soln
electrolytes
change color of indicator


Ch 15/16 Acids & Bases
Simple Properties of Acids + Bases
Acids
Low pH (Below 7)
give off H^+ in soln
Electrolytes
Change color of indicators
Sour taste
Litmus - Red in Acid
Blue in Base
phenolphthalein - colorless in Acid
Pink in Base
Bases
high pH (above 7)
give off OH^- in soln
Electrolytes
Change color of indicator
Bitter Taste


Ch 15/16 Acids & Bases
Simple Properties of Acids + Bases
Acids
Low pH (Below 7)
give off H^+ in soln
Electrolytes
Change color of indicators
Sour taste
Neutralize Bases
Litmus - Red in Acid
Blue in Base
phenolphthalein - colorless in Acid
Pink in Base
Bases
high pH (above 7)
give off OH^- in soln
Electrolytes
Change color of indicator
Bitter Taste
Neutralize Acids


Ch 15/16 Acids & Bases
Simple Properties of Acids + Bases
Acids
Low pH (Below 7)
give off H^+ in soln
electrolytes
Change color of indicators
Sour taste
Neutralize Bases
Litmus - Red in Acid
Blue in Base
phenolphthalein - colorless in Acid
Pink in Base
Bases
high pH (above 7)
give off OH^- in soln
electrolytes
Change color of indicator
Bitter Taste
Neutralize Acids
Feel Slippery

Definitions of Acids + Bases

Definitions of Acids + Bases

Arrhenius Def. (Traditional)

Definitions of Acids + Bases

Arrhenius Def. (Traditional)

Acid

Definitions of Acids + Bases

Arrhenius Def. (Traditional)

Acid

any comp that contains H & creates H^+ ions (H_3O^+) in soln.

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$H_2O + HCl \longrightarrow$

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$$H_2O + HCl \longrightarrow H_3O^+ + Cl^-$$

(Hydronium)

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any comp that contains H & creates H^+ ions (H_3O^+) in soln.

$HCl \xrightarrow[\text{or}]{H_2O} H^+_{(aq)} + Cl^-_{(aq)}$

$H_2O + HCl \longrightarrow H_3O^+ + Cl^-$

(Hydronium)

Base

any comp that creates OH^- in soln.

Definitions of Acids + Bases

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any comp that contains H & creates H^+ ions (H_3O^+) in soln.

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$H_2O + HCl \longrightarrow H_3O^+ + Cl^-$

(Hydronium)

Base

any comp that creates OH^- in soln.

$NaOH \xrightarrow{H_2O} Na^+ + OH^-$

Definitions of Acids + Bases

Arrhenius Def. (Traditional)

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any comp that contains H & creates H^+ ions (H_3O^+) in soln.

$HCl \xrightarrow[\text{or}]{H_2O} H^+_{(aq)} + Cl^-_{(aq)}$

$H_2O + HCl \longrightarrow H_3O^+ + Cl^-$

(Hydronium)

Base

any comp that creates OH^- in soln.

$NaOH \xrightarrow{H_2O} Na^+ + OH^-$

$H_2O + NH_3 \longrightarrow NH_4^+ + OH^-$

Naming Acids

Naming Acids

Binary

H + other element

Naming Acids

Binary

H + other element

Ternary (oxyacids)

Naming Acids

Binary
H + other element

Ternary (oxyacids)
H + polyatomic ion

Naming Acids

Binary

H + other element

HCl hydrochloric acid

hydro- element name -ic acid

Ternary (oxyacids)

H + polyatomic ion

Naming Acids

Binary

H + other element

HCl — hydrochloric acid

hydro- element name -ic acid

HBr — hydrobromic acid

Ternary (oxyacids)

H + polyatomic ion

Naming Acids

Binary

H + other element

HCl — hydrochloric acid

hydro- element name -ic acid

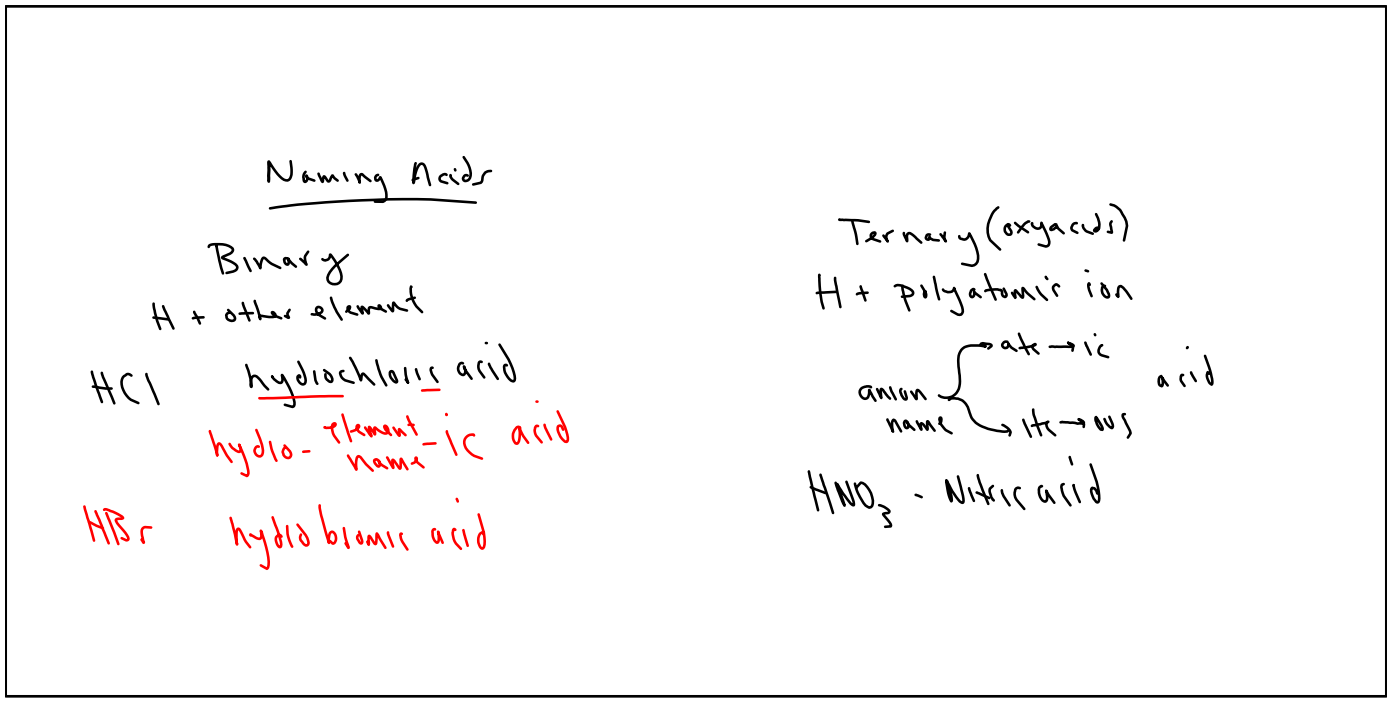
HBr — hydrobromic acid

Ternary (oxyacids)

H + polyatomic ion

anion name: -ate → -ic; -ite → -ous

acid


Naming Acids
Binary
H + other element
HCl
hydrochloric acid
hydro- element name -ic acid
HBr
hydrobromic acid
Ternary (oxyacids)
H + polyatomic ion
anion name
-ate → -ic
-ite → -ous
acid
HNO3 - Nitric acid

Naming Acids

Binary

H + other element

HCl — hydrochloric acid

hydro- element name -ic acid

HBr — hydrobromic acid

Ternary (oxyacids)

H + polyatomic ion

anion name: -ate → -ic; -ite → -ous — acid

HNO_3 - Nitric acid

$HClO_2$ -

Naming Acids

Binary

H + other element

HCl — hydrochloric acid

hydro- element name -ic acid

HBr — hydrobromic acid

Ternary (oxyacids)

H + polyatomic ion

anion name: -ate → -ic; -ite → -ous — acid

HNO_3 - Nitric acid

$HClO_2$ - chlorous acid

Naming Acids

Binary

H + other element

HCl — hydrochloric acid

hydro- element name -ic acid

HBr — hydrobromic acid

Ternary (oxyacids)

H + polyatomic ion

anion name: -ate → -ic; -ite → -ous

HNO_3 - Nitric acid

$HClO_2$ - chlorous acid

acid

NO Hydro Prefix

Bronsted-Lowry Acids/Bases

Bronsted-Lowry Acids/Bases

Acids

proton donor
(H^+)

Brønsted-Lowry Acids/Bases

Acids

proton donor
(H^+)

Base

proton acceptor

Bronsted-Lowry Acids/Bases

Acids

proton donor (H^+)

Base

proton acceptor

$$HF + H_2O \rightleftharpoons F^- + H_3O^+$$

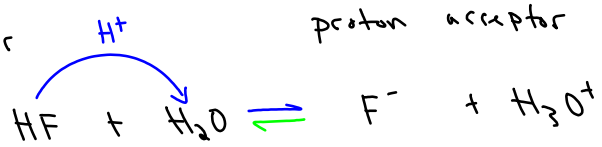
Brønsted-Lowry Acids/Bases

Acids

proton donor (H^+)

Base

proton acceptor



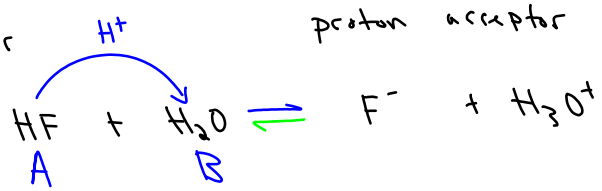
Brønsted-Lowry Acids/Bases

Acids

proton donor (H^+)

Base

proton acceptor



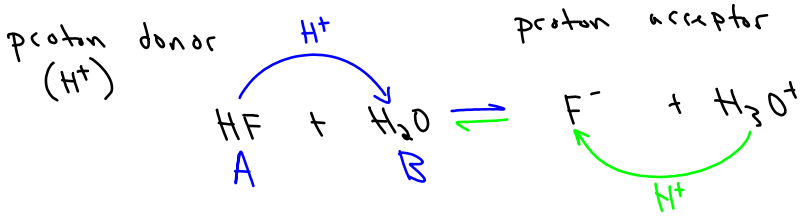
Brønsted-Lowry Acids/Bases

Acids

proton donor (H^+)

Base

proton acceptor



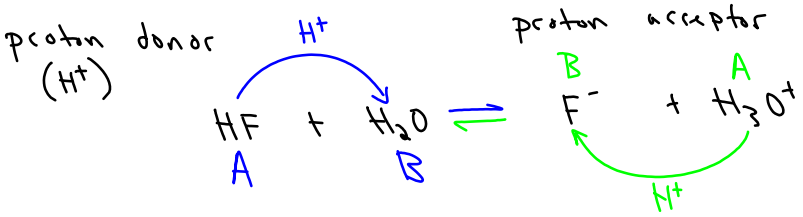
Brønsted-Lowry Acids/Bases

Acids

proton donor (H^+)

Base

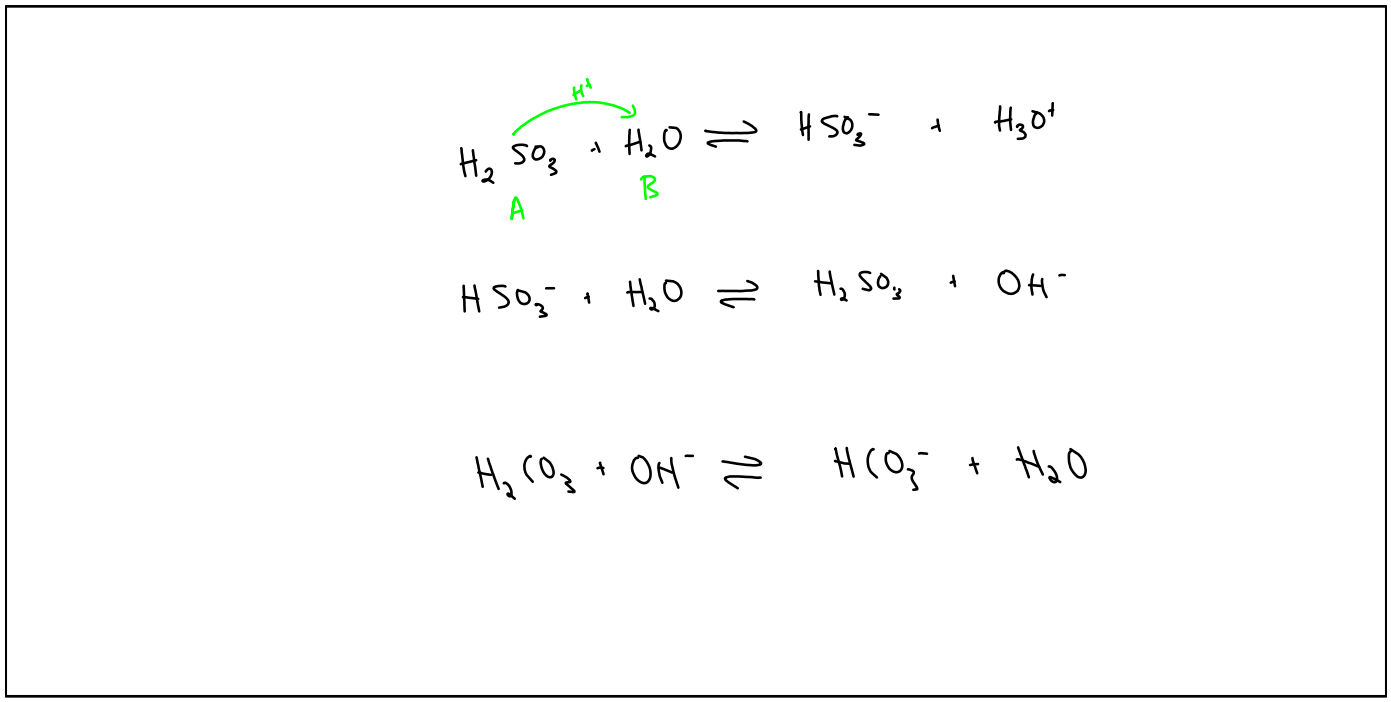
proton acceptor

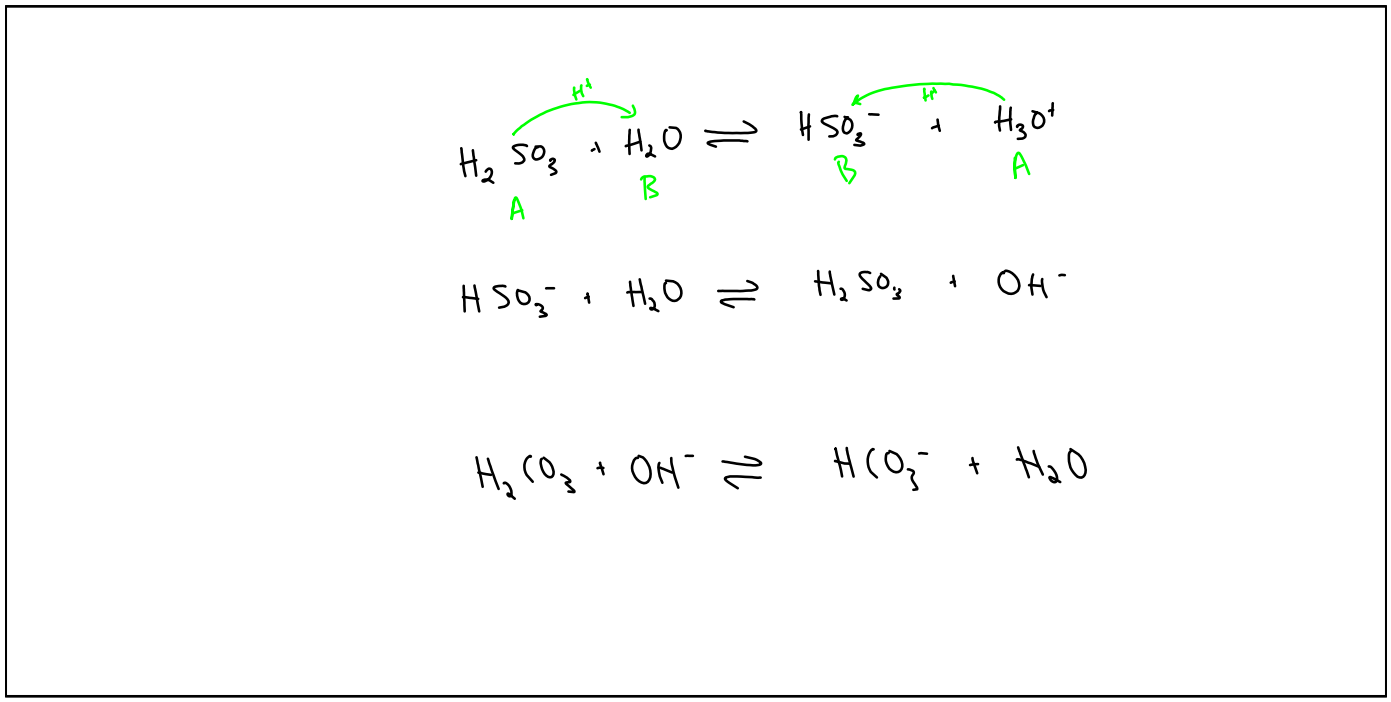


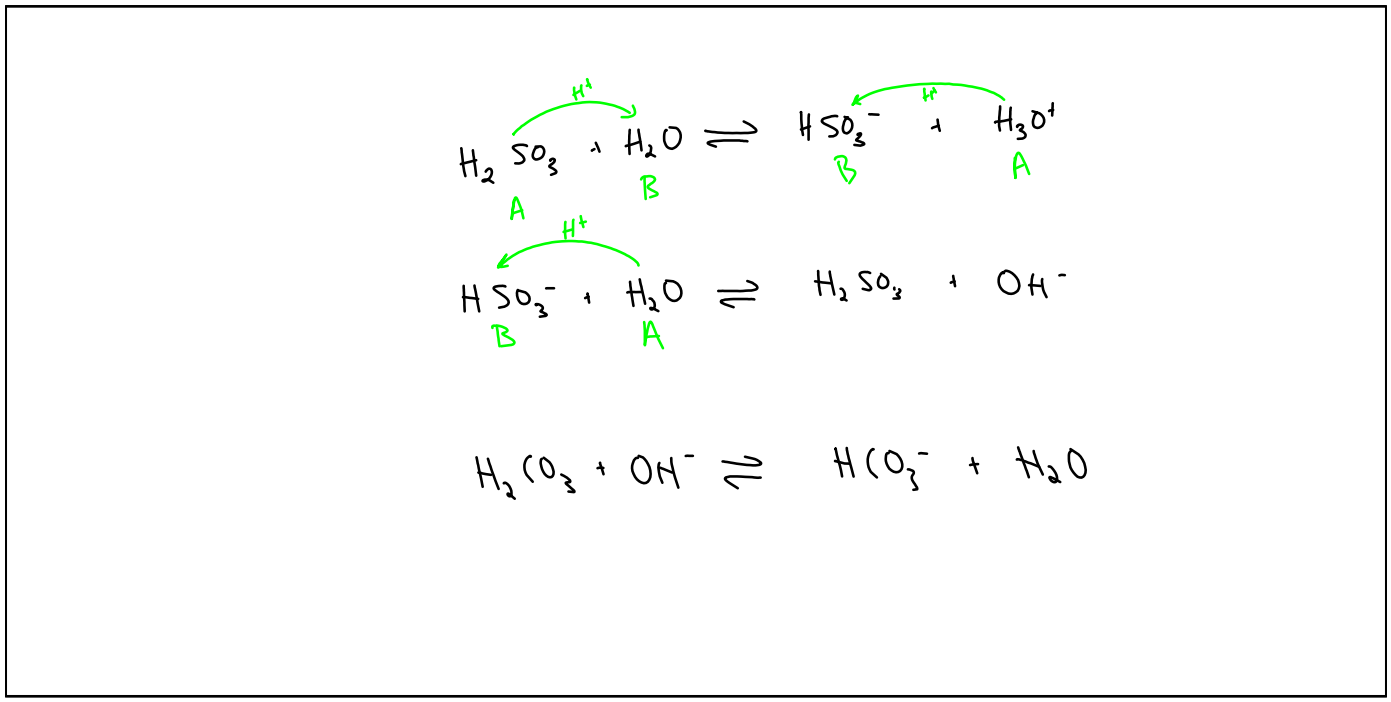
$$H_2SO_3 + H_2O \rightleftharpoons HSO_3^- + H_3O^+$$

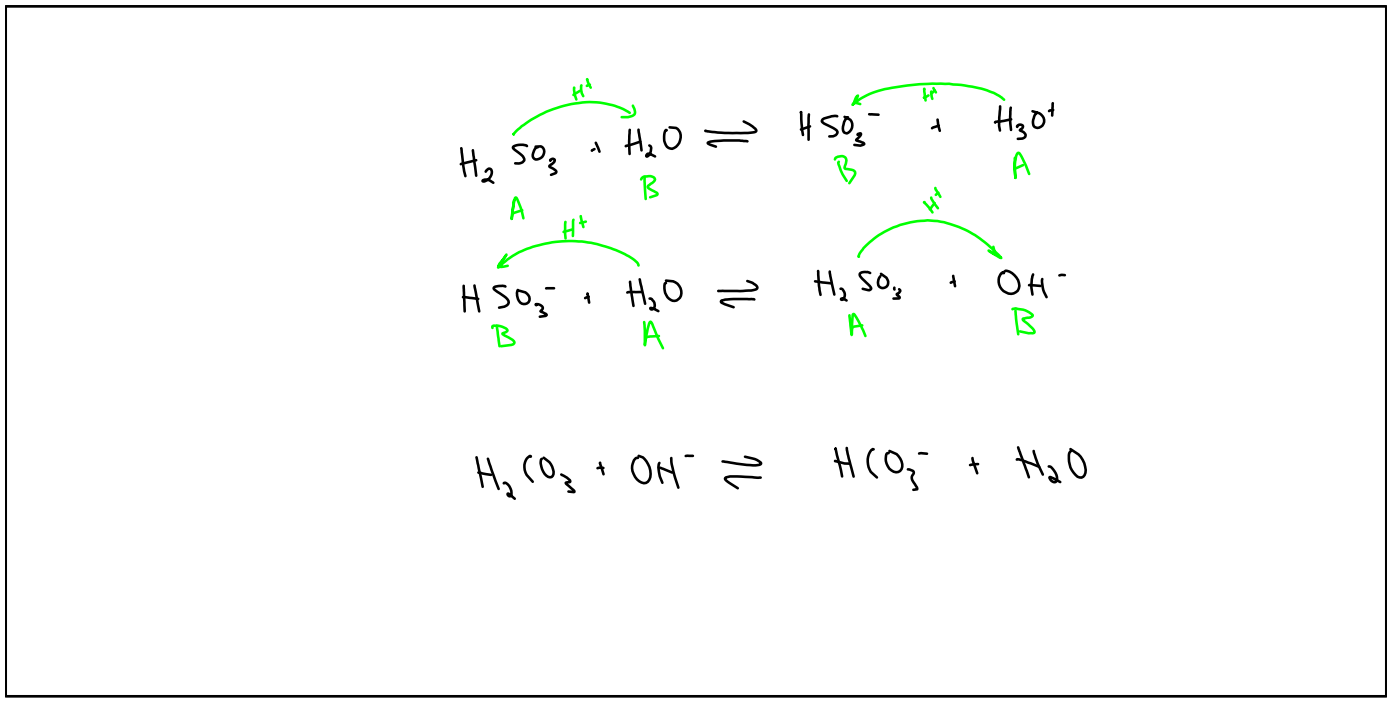
$$HSO_3^- + H_2O \rightleftharpoons H_2SO_3 + OH^-$$

$$H_2CO_3 + OH^- \rightleftharpoons HCO_3^- + H_2O$$


H+
H2SO3 + H2O ⇌ HSO3- + H3O+
A
B
HSO3- + H2O ⇌ H2SO3 + OH-
H2CO3 + OH- ⇌ HCO3- + H2O


H+
H+
H2SO3 + H2O ⇌ HSO3− + H3O+
A B B A
HSO3− + H2O ⇌ H2SO3 + OH−
H2CO3 + OH− ⇌ HCO3− + H2O


H+
H2SO3 + H2O ⇌ HSO3- + H3O+
A B B A
H+
HSO3- + H2O ⇌ H2SO3 + OH-
B A
H2CO3 + OH- ⇌ HCO3- + H2O


H+
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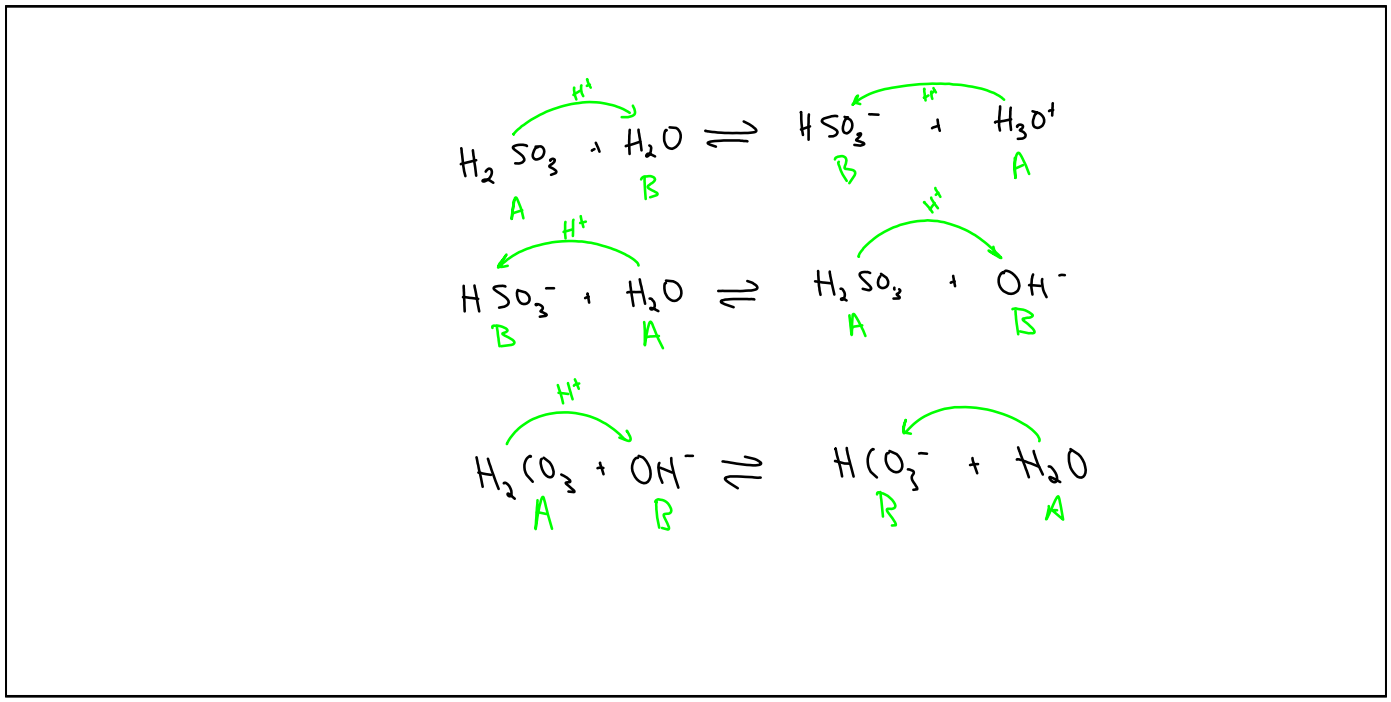
H+
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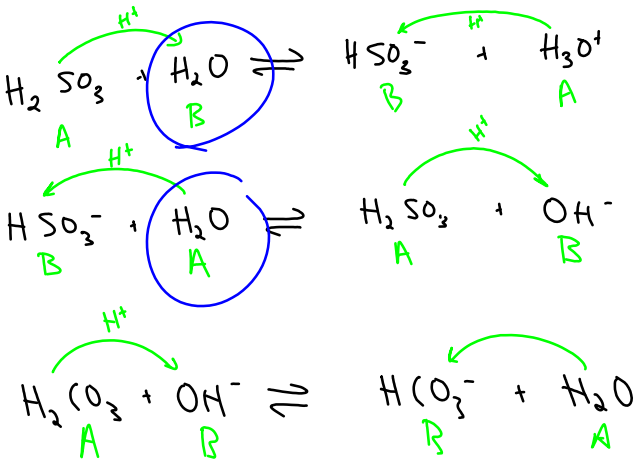
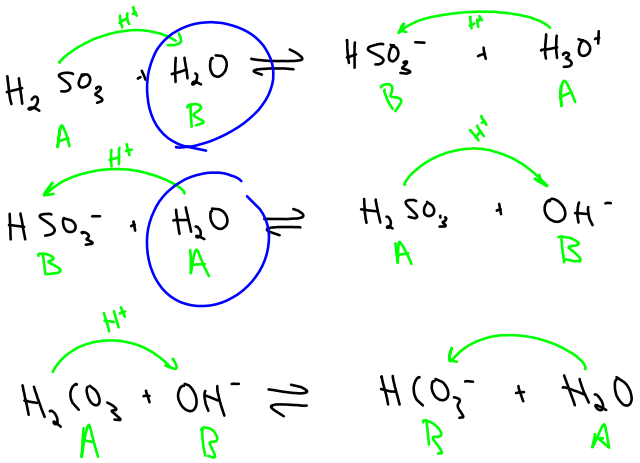
A B B A
H+
HSO3- + H2O ⇌ H2SO3 + OH-
B A A B
H+
H2CO3 + OH- ⇌ HCO3- + H2O
A B B A

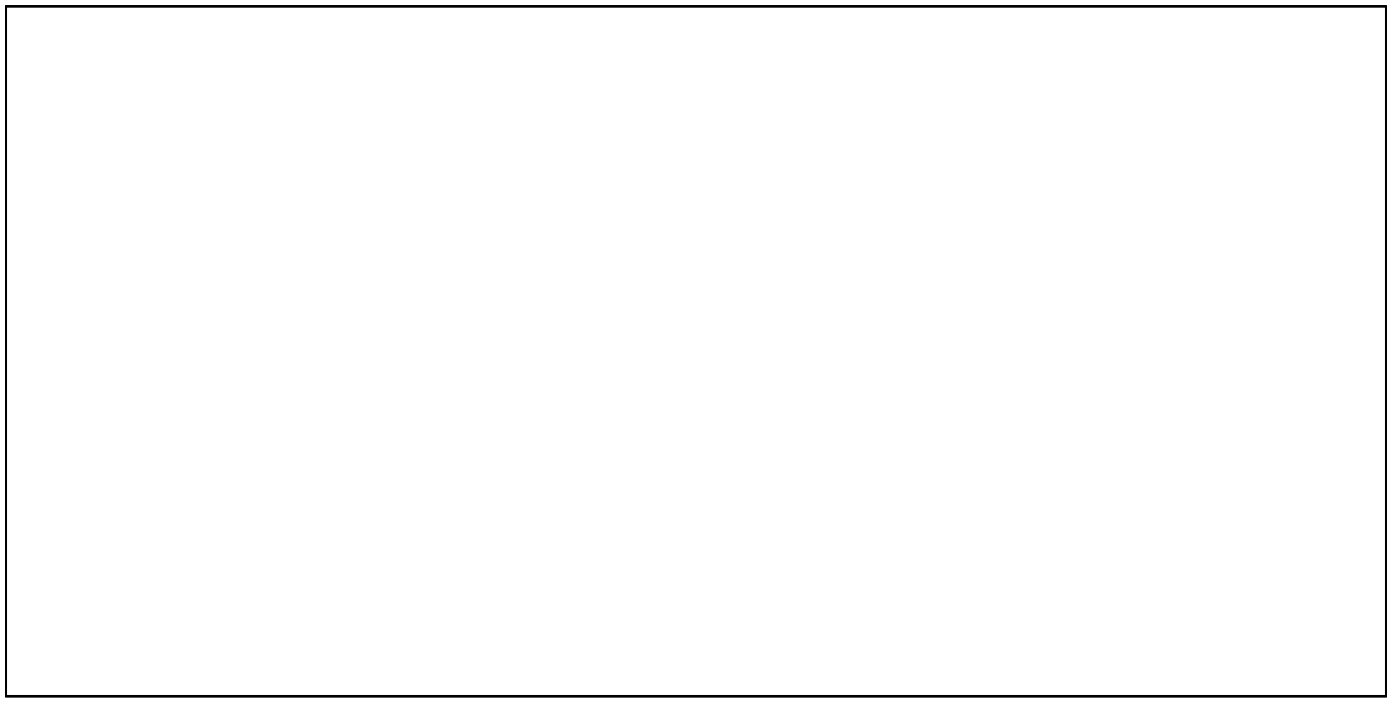
H_2O is acting as an acid & a base



H_2O is acting as an acid & a base

Amphoteric - act as an acid or a base





Self ionization of H_2O

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↳ H_2O molecules Break apart occasionally

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$$H_2O \rightleftharpoons H^+ + OH^-$$

Self ionization of H_2O

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In pure H_2O → $[H^+] = 1 \times 10^{-7}\ M$

Self ionization of H_2O

↳ H_2O molecules Break apart occasionally

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In pure H_2O → $[H^+] = 1 \times 10^{-7}\ M$

$[OH^-] = 1 \times 10^{-7}\ M$

Calculating pH

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$$pH = -\log[H^+]$$

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for pure H_2O $pH =$

Calculating pH

$pH = -\log[H^+]$

for pure H_2O $pH = -\log(1 \times 10^{-7} M)$

Calculating pH

$pH = -\log[H^+]$

for pure H_2O $pH = -\log(1 \times 10^{-7} M)$

$= 7$

pH of Acids

pH of Acids

Strong Acids - fully ionize)

pH of Acids

Strong Acids - fully ionize)

$HCl \xrightarrow{100\%} H^+ + Cl^-$

pH of Acids

Strong Acids - fully ionize)

$HCl \xrightarrow{100\%} H^+ + Cl^-$

$0.10M \longrightarrow [H^+] = 0.10M$

$pH = -\log(0.1M)$

$= 1$

pH of Acids

Strong Acids - fully ionize)

$HCl \xrightarrow{100\%} H^+ + Cl^-$

$0.10M \longrightarrow [H^+] = 0.10M$

$pH = -\log(0.10M)$

$= 1$

Weak acids - don't fully ionize

$HF \xrightarrow{10\%} H^+ + F^-$

pH of Acids

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$0.10M \longrightarrow [H^+] = 0.10M$

$pH = -\log(0.1M)$

$= 1$

Weak acids - don't fully ionize

$HF \xrightarrow{10\%} H^+ + F^-$

$0.1M \longrightarrow [H^+] = 0.1M \times 0.1 = 0.01M$

$pH = -\log(0.01M) = 2$

Calculating pH of Basic solutions

Calculating pH of Basic solutions → use pOH, then find pH

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$pOH = -\log[OH^-]$

Calculating pH of Basic solutions → use pOH, then find pH

$pOH = -\log[OH^-]$ $\quad pH = 14 - pOH$

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Strong Bases - fully ionize

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$pOH = -\log[OH^-]$ $\quad pH = 14 - pOH$

Strong Bases - fully ionize

$NaOH \xrightarrow{100\%} Na^+ + OH^-$

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$pOH = -\log[OH^-]$ $\quad pH = 14 - pOH$

Strong Bases - fully ionize

$NaOH \xrightarrow{100\%} Na^+ + OH^-$

0.01 M

Calculating pH of Basic solutions → use pOH, then find pH

$pOH = -\log[OH^-]$ $\quad pH = 14 - pOH$

Strong Bases - fully ionize

$NaOH \xrightarrow{100\%} Na^+ + OH^-$

$0.01\ M \longrightarrow [OH^-] = 0.01\ M$

Calculating pH of Basic solutions → use pOH, then find pH

$pOH = -\log[OH^-]$ $\quad pH = 14 - pOH$

Strong Bases - fully ionize

$NaOH \xrightarrow{100\%} Na^+ + OH^-$

$0.01\ M \longrightarrow [OH^-] = 0.01\ M$

$pOH = -\log(0.01\ M) = 2$

Calculating pH of Basic solutions → use pOH, then find pH

$pOH = -\log[OH^-]$ $\quad pH = 14 - pOH$

Strong Bases - fully ionize

$NaOH \xrightarrow{100\%} Na^+ + OH^-$

$0.01\,M \longrightarrow [OH^-] = 0.01\,M$

$pOH = -\log(0.01\,M) = 2$

$pH = 14 - 2 = 12$

Calculating pH of Basic solutions → use pOH, then find pH

$pOH = -\log[OH^-]$

$pH = 14 - pOH$

Strong Bases - fully ionize

$NaOH \xrightarrow{100\%} Na^+ + OH^-$

$0.01\ M \longrightarrow [OH^-] = 0.01\ M$

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$pH = 14 - 2 = 12$

Weak bases don't fully ionize

Calculating pH of Basic solutions → use pOH, then find pH

$pOH = -\log[OH^-]$

$pH = 14 - pOH$

Strong Bases - fully ionize

$NaOH \xrightarrow{100\%} Na^+ + OH^-$

$0.01\,M \longrightarrow [OH^-] = 0.01\,M$

$pOH = -\log(0.01\,M) = 2$

$pH = 14 - 2 = 12$

Weak bases don't fully ionize

$AgOH \xrightarrow{5\%} Ag^+ + OH^-$

Calculating pH of Basic solutions → use pOH, then find pH

$pOH = -\log[OH^-]$ $\quad pH = 14 - pOH$

Strong Bases - fully ionize

$NaOH \xrightarrow{100\%} Na^+ + OH^-$

0.01 M → $[OH^-] = 0.01\,M$

$pOH = -\log(0.01\,M) = 2$

$pH = 14 - 2 = 12$

weak bases don't fully ionize

$AgOH \xrightarrow{5\%} Ag^+ + OH^-$

0.01 M

Calculating pH of Basic solutions → use pOH, then find pH

$pOH = -\log[OH^-]$ $\quad pH = 14 - pOH$

Strong Bases - fully ionize

$NaOH \xrightarrow{100\%} Na^+ + OH^-$

$0.01\,M \longrightarrow [OH^-] = 0.01\,M$

$pOH = -\log(0.01\,M) = 2$

$pH = 14 - 2 = 12$

Weak bases don't fully ionize

$AgOH \xrightarrow{5\%} Ag^+ + OH^-$

$0.01\,M \longrightarrow [OH^-] = 0.01\,M \times 0.05 = 0.0005\,M$

Calculating pH of Basic solutions → use pOH, then find pH

$pOH = -\log[OH^-]$ $\quad pH = 14 - pOH$

Strong Bases - fully ionize

$NaOH \xrightarrow{100\%} Na^+ + OH^-$

$0.01\,M \longrightarrow [OH^-] = 0.01\,M$

$pOH = -\log(0.01\,M) = 2$

$pH = 14 - 2 = 12$

weak bases don't fully ionize

$AgOH \xrightarrow{5\%} Ag^+ + OH^-$

$0.01\,M \longrightarrow [OH^-] = 0.01\,M \times 0.05 = 0.0005\,M$

$pOH = -\log(0.0005\,M) =$

Calculating pH of Basic solutions → use pOH, then find pH

$pOH = -\log[OH^-]$ $\quad pH = 14 - pOH$

Strong Bases - fully ionize

$NaOH \xrightarrow{100\%} Na^+ + OH^-$

$0.01\,M \longrightarrow [OH^-] = 0.01\,M$

$pOH = -\log(0.01\,M) = 2$

$pH = 14 - 2 = 12$

weak bases don't fully ionize

$AgOH \xrightarrow{5\%} Ag^+ + OH^-$

$0.01\,M \longrightarrow [OH^-] = 0.01\,M \times 0.05 = 0.0005\,M$

$pOH = -\log(0.0005\,M) = 3.3$

Calculating pH of Basic solutions → use pOH, then find pH

$pOH = -\log[OH^-]$ $\quad pH = 14 - pOH$

Strong Bases - fully ionize

$NaOH \xrightarrow{100\%} Na^+ + OH^-$

$0.01\,M \longrightarrow [OH^-] = 0.01\,M$

$pOH = -\log(0.01\,M) = 2$

$pH = 14 - 2 = 12$

Weak bases don't fully ionize

$AgOH \xrightarrow{5\%} Ag^+ + OH^-$

$0.01\,M \longrightarrow [OH^-] = 0.01\,M \times 0.05 = 0.0005\,M$

$pOH = -\log(0.0005\,M) = 3.3$

$pH = 14 - 3.3 = 10.7$

using a soln of known concentration
to determine the unknown conc. of another soln.

using a soln of known concentration
to determine the unknown conc. of another soln.

Standard soln

using a soln of known concentration
to determine the unknown conc. of another soln.

Standard soln

Acid/Base Titration - use a neutralization Rxn to determine the conc. of an acid or a base

using a soln of known concentration
to determine the unknown conc. of another soln.

Standard soln

Acid/Base Titration - use a neutralization Rxn to determine the conc. of an acid or a base

↳ Add Acid & Base until they are chemically equal

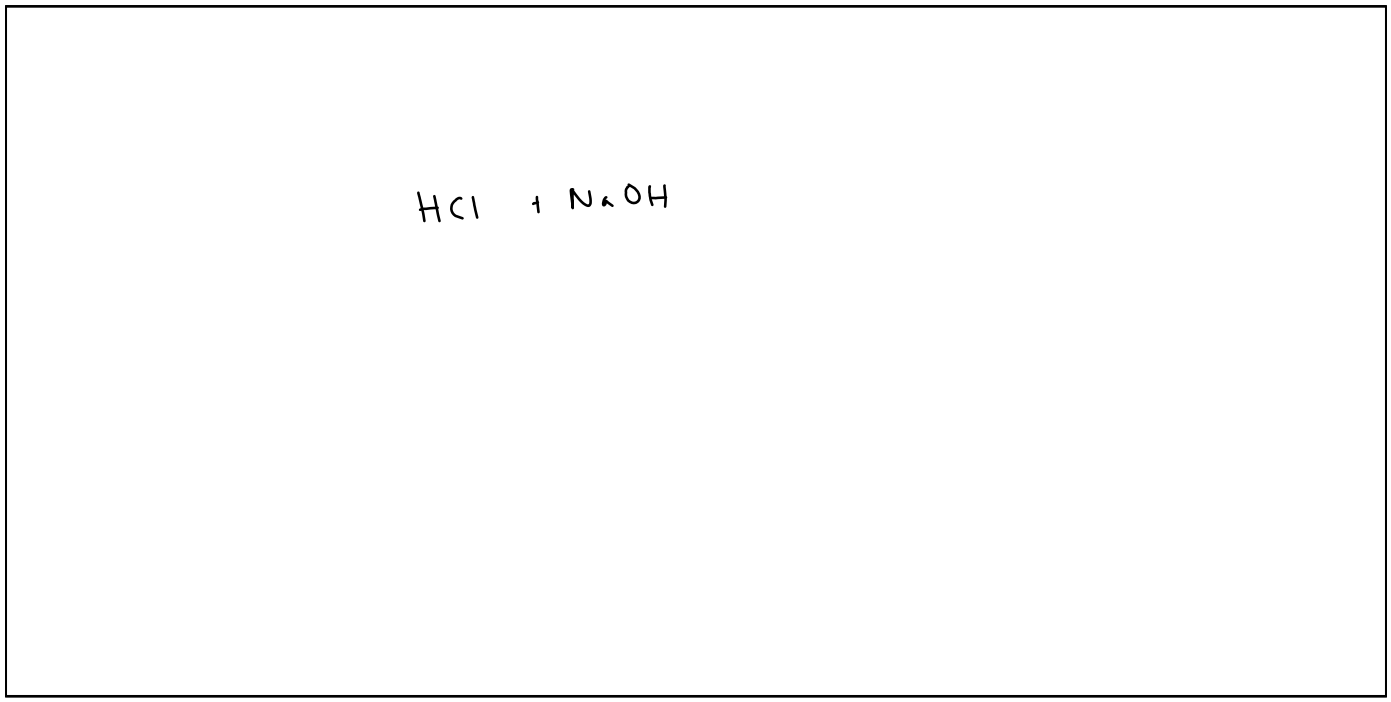
using a soln of known concentration
to determine the unknown conc. of another soln.

Standard soln

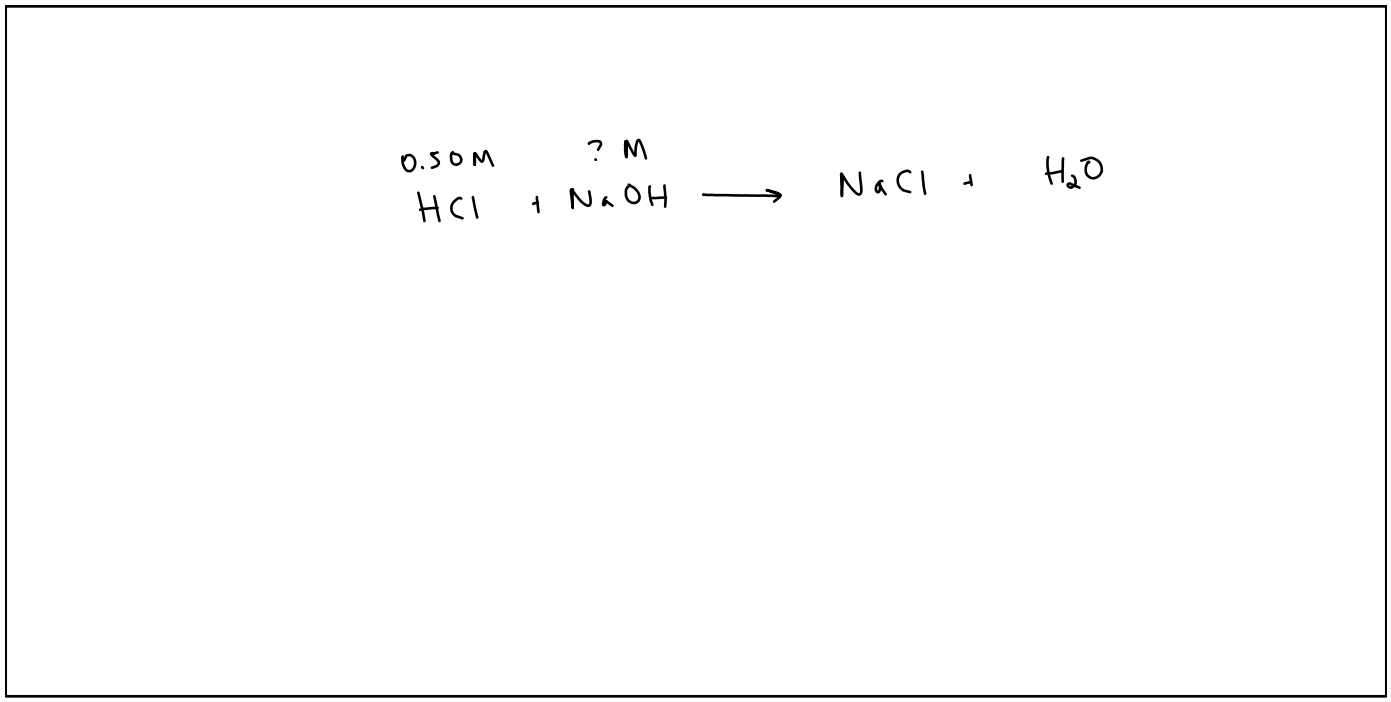
Acid/Base Titration - use a neutralization Rxn to determine the conc. of an acid or a base

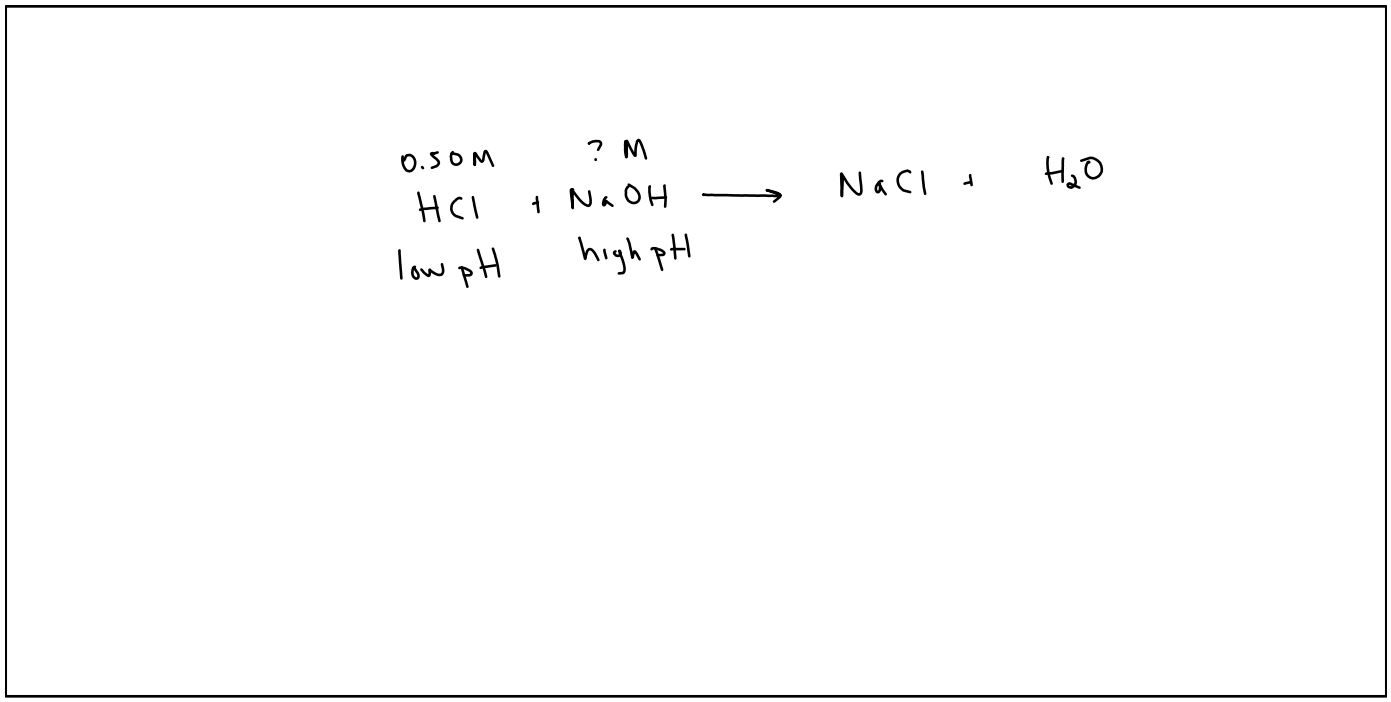
↳ Add Acid & Base until they are chemically Equal

Equivalence Pt. - Pt where mol Acid equal moles of Base in a titration


HCl + NaOH

0.50 M ? M
HCl + NaOH


0.50M
? M
HCl + NaOH → NaCl + H2O


0.50 M
? M
HCl + NaOH → NaCl + H2O
low pH
high pH

0.50 M ? M

$HCl + NaOH \longrightarrow NaCl + H_2O$

low pH high pH

combine A/B to get Neutral pH

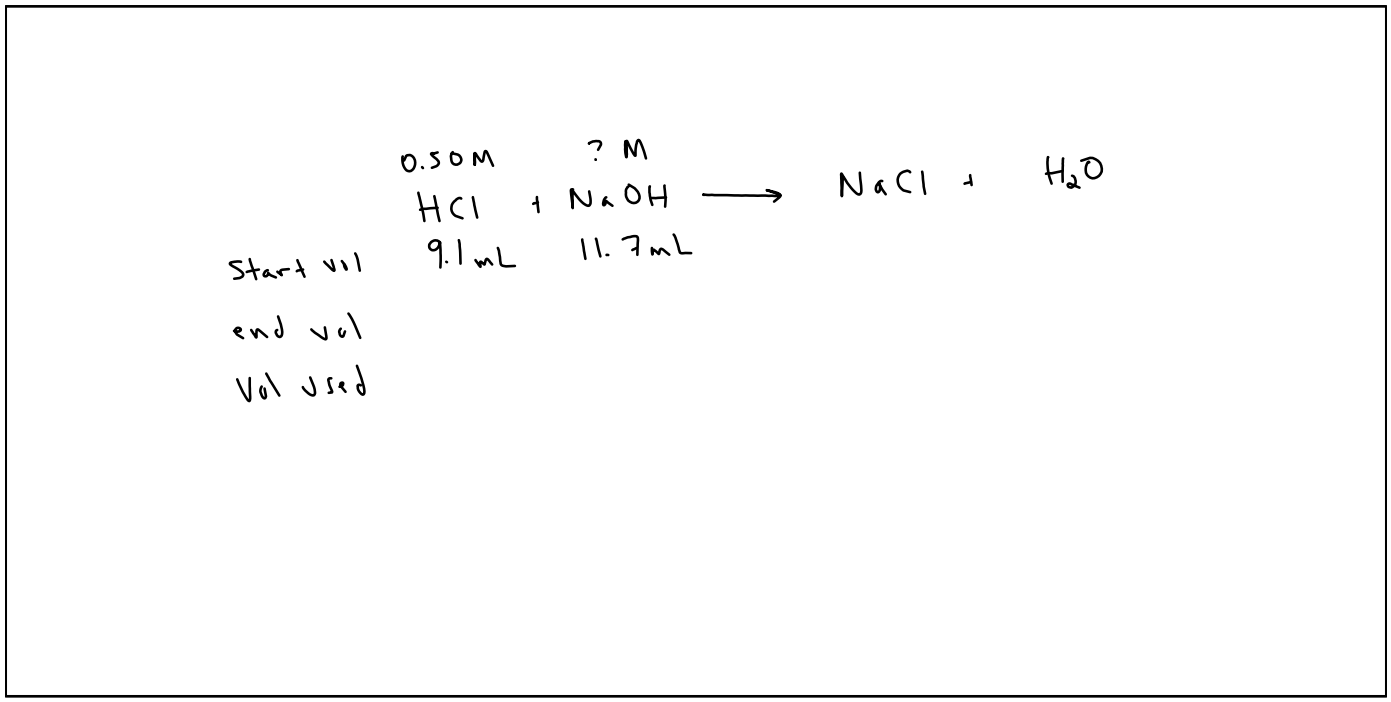
0.50 M ? M

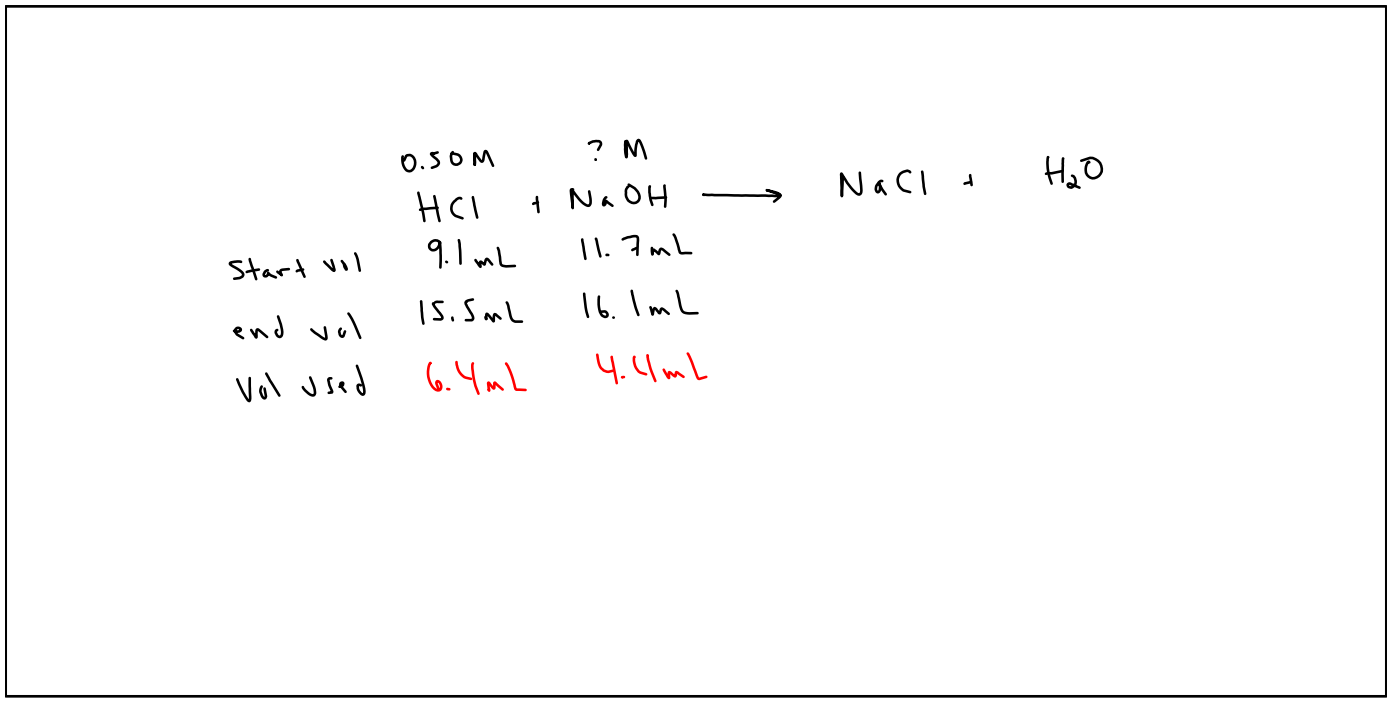
$HCl + NaOH \longrightarrow NaCl + H_2O$

low pH high pH

combine A/B to get Neutral pH

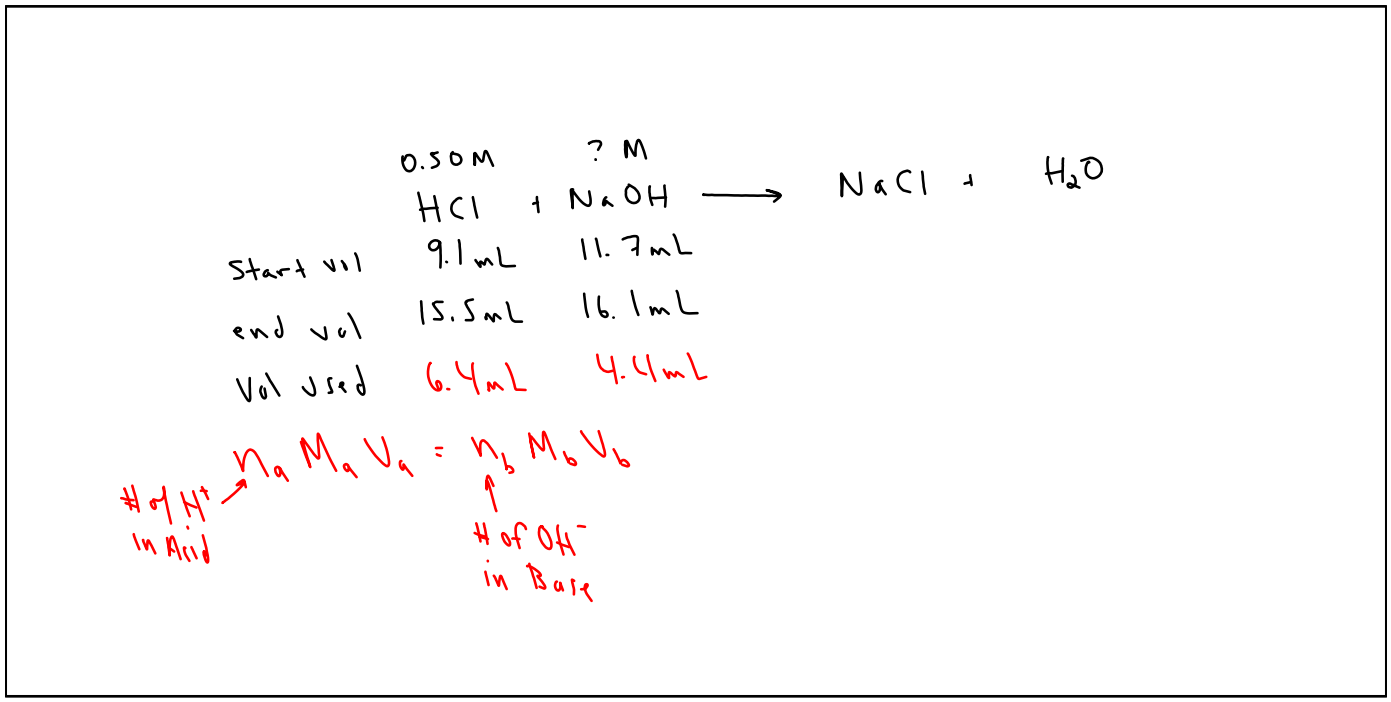
↳ Neutral pH is where the Equivalence Pt (EqPt) is and it is shown by an indicator changing color.

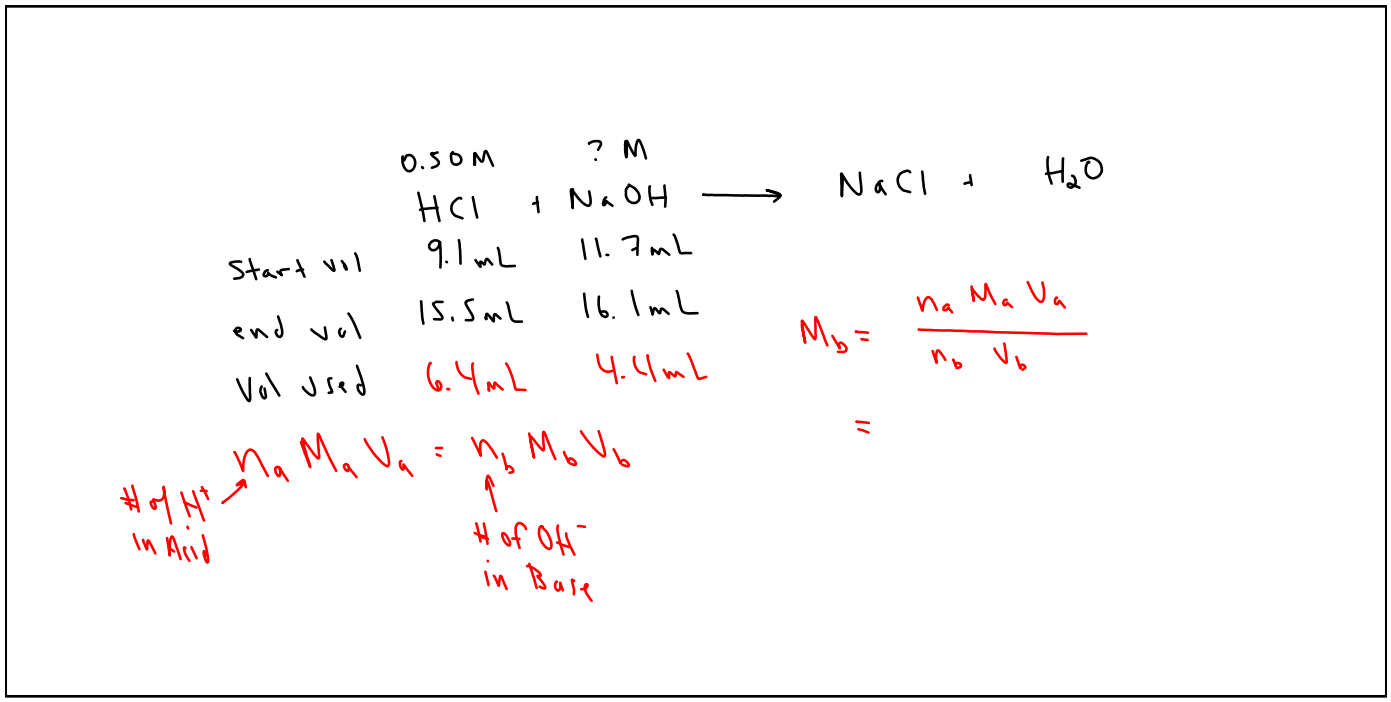

0.50M
? M
HCl + NaOH → NaCl + H2O
9.1mL
11.7mL
Start vol
end vol
Vol used

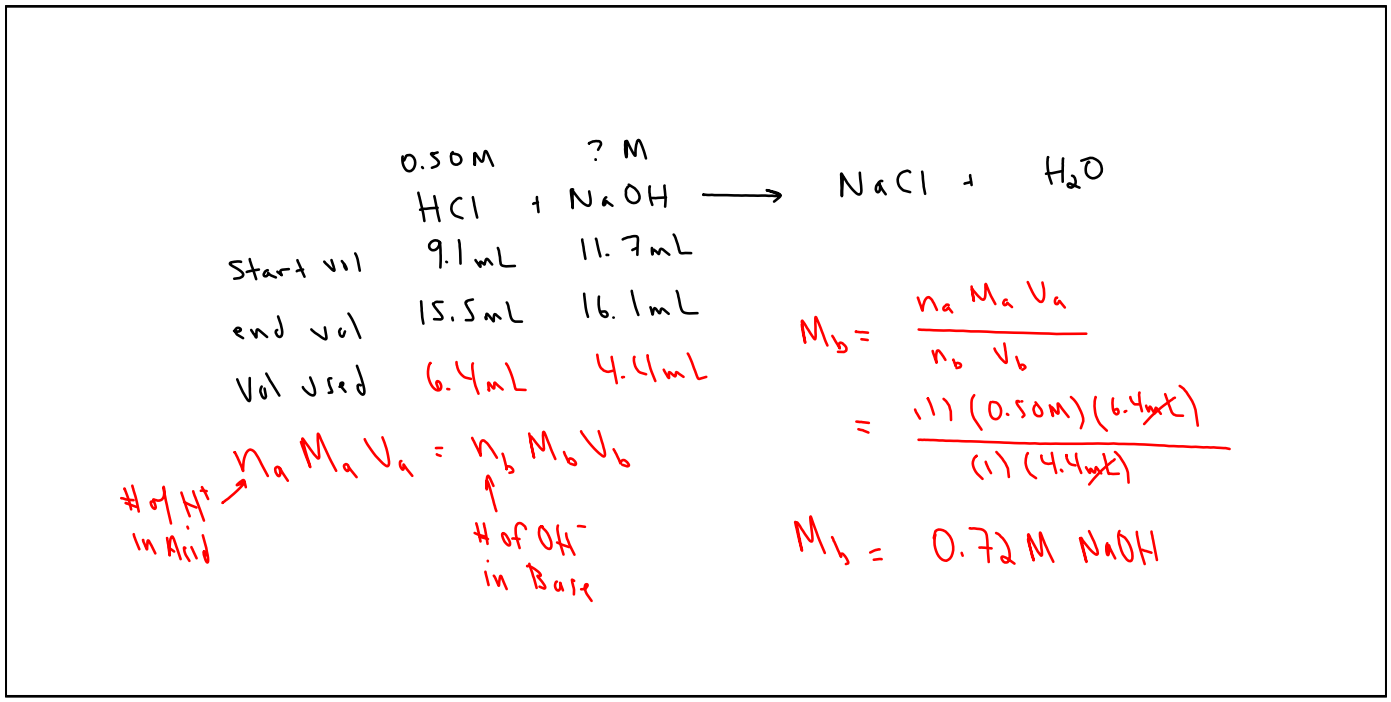

0.50 M
? M
HCl + NaOH → NaCl + H2O
Start vol 9.1 mL 11.7 mL
end vol 15.5 mL 16.1 mL
Vol used 6.4 mL 4.4 mL

	0.50 M HCl	? M NaOH	→ NaCl	+ H_2O
Start vol	9.1 mL	11.7 mL		
end vol	15.5 mL	16.1 mL		
Vol used	6.4 mL	4.4 mL		

$n_a M_a V_a = n_b M_b V_b$


0.50 M
? M
HCl + NaOH → NaCl + H2O
Start vol 9.1 mL 11.7 mL
end vol 15.5 mL 16.1 mL
Vol used 6.4 mL 4.4 mL
na Ma Va = nb Mb Vb
# of H+ in Acid
# of OH- in Base


0.50 M
? M
HCl + NaOH → NaCl + H2O
Start vol 9.1 mL 11.7 mL
end vol 15.5 mL 16.1 mL
Vol used 6.4 mL 4.4 mL
na Ma Va = nb Mb Vb
# of H+ in Acid
# of OH- in Base
Mb = na Ma Va / nb Vb
=


0.50 M
? M
HCl + NaOH → NaCl + H2O
Start vol 9.1 mL 11.7 mL
end vol 15.5 mL 16.1 mL
Vol used 6.4 mL 4.4 mL
na Ma Va = nb Mb Vb
# of H+ in Acid
# of OH- in Base
Mb = na Ma Va / nb Vb
= (1)(0.50 M)(6.4 mL) / (1)(4.4 mL)
Mb = 0.72 M NaOH